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ABSTRACT

Recognition memory of components of complex pictures was assessed developmentally for kindergarteners, third and sixth graders, and college students. It was assumed that the relations among items in multi-component line drawings are constrained by at least two organizational dimensions, structure and content, which influence retention of pictured information. Each subject viewed slides of structurally integrated and unintegrated versions of coherent and anomalous scenes. One component in each scene served as a target on a yes/no recognition test. With regard to the organizational dimensions, the results showed clear effects of scene content across developmental levels. Developmental differences were observed in two aspects of the recognition memory task: Kindergarteners used more conservative response criteria than older subjects, and the recognition accuracy of college students was superior to that of the children. (Author)

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ED140128

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The Influence of Age and Intrastimulus Organization on Recognition Memory of Information in Complex Pictures

There is evidence that visual processing and storage of complex pictures improves with developmental maturity (cf. Day, 1975; Hagen, 1974; Mandler & Stein 1974; Potter, 1966). Mandler and Stein (1974) have demonstrated that developmental improvements in retention of information in complex, i.e. multi-component, pictures may be related to their inherent structural organization. Other theorists have emphasized that well-organized complex pictures are constrained not only by acceptable interitem spatial relations but also by the a priori probability that pictured components occur together in the real world (Biederman, Rabinowitz, Glass, & Stacy, 1974; Loftus & Bell, 1975). It appears that components of complex pictures are organized along at least two dimensions; one regulates scene structure and the other scene content. The aim of the present study was to assess recognition memory for component information in complex pictures developmentally as a function of the two stimulus organizational dimensions of content and structure.

Constraints on structural organization have been demonstrated to facilitate children's recognition (Mandler & Stein, 1974) and recall (Horowitz, Lampel, & Takanishi, 1969) of component information from thematically intact scenes, although adults' recognition appears to be independent of scene structure (Mandler & Johnson, 1976; Mandler & Parker, 1976). Mandler and Stein (1974) reported

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that children recognized transformations of acquisition scene components better if the acquisition scenes had been presented as naturalistic (structurally organized) rather than jumbled (structurally unorganized) arrays. They hypothesized that children processed naturalistic and jumbled scenes differently. Given naturalistic scenes, children seem to focus on interitem relationships and encode the scene as a whole; when processing jumbled scenes, children tend to focus on individual items and details. Thus, while adults should recognize components from structurally organized and unorganized scenes equally well (Mandler & Johnson, 1976; Mandler & Parker, 1976), children should recognize components from structurally unorganized scenes better than those from structurally organized scenes (Mandler & Stein, 1974), at least when scenes are thematically coherent or intact.

Although efforts to demonstrate developmental differences in picture recognition due to variations in content are rare and usually unsuccessful (e.g., Fleming & Sheikhian, 1972), it has been shown that scene content does affect processing and recognition of complex pictures among adults. Loftus and Bell (1975) hypothesized that the type of information a component adds to a scene affects encoding and retention of complex pictures. Adults remembered specific informative details better than information adding in a general way to the meaning conveyed by a scene.

The present experiment assessed developmental implications of the notions proposed by Mandler and her associates (Mandler &

Johnson, 1976; Mandler & Parker 1976; Mandler & Stein, 1974] and Loftus and Bell [1975] regarding processing and recognition of component information from scenes varying in structure and content. Structural integration and thematic content of scenes were varied in the following way. Thematic content was defined in terms of the probability that a collection of items would occur together in a real-world scene. In thematically coherent scenes, all components shared a common theme (e.g., things found in a livingroom); in anomalous scenes, a thematically incongruent component was substituted for one of the coherent items (e.g. a playground swing in a livingroom). Structural integration was determined by constraints on interitem spatial relations. For integrated scenes, components were arranged naturalistically, while for unintegrated scenes components were arranged in a horizontal line. Kindergarten, third and sixth grade, and college students had to correctly recognize a component from each scene from a list containing semantically related distractors.

It follows from the above discussion that the effects of scene structure on encoding and retention should change with age and scene content. Across developmental levels, anomalous scene components should be recognized better than coherent ones regardless of scene structure. Because anomalous components can be thought of as informative details, adults should recognize them better than coherent components of thematically homogeneous scenes (Loftus & Bell, 1975). It seems reasonable to expect a similar effect among children to the

extent that anomalous items are more salient than coherent ones, increasing the probability of the anomalous item being attended to, encoded, and later recognized (Wright & Vlietstra, 1975). The effect of scene structure on encoding and recognition of information from coherent scenes should vary with developmental level. Kindergarteners are expected to encode coherent scenes as given (Mandler & Stein, 1974), i.e., without actively restructuring during encoding (Brown, 1975). This nonstrategic encoding should produce facilitation in recognizing unintegrated relative to integrated components to the extent that the match between stored representations and items presented for recognition is apt to be greater for unintegrated than integrated components. Older children and adults are expected to integrate unintegrated scenes (cf. Hagen et al., 1975) resulting in functionally equivalent encoded representations and similar levels of recognition for components of integrated and unintegrated scenes (Mandler & Johnson, 1976; Mandler & Parker, 1976). Finally, the overall level of component recognition accuracy should increase with developmental level as children become more capable of extracting information about components from conglomerates during encoding and retrieval, and as they encode progressively more aspects of the presented scenes (cf. Day, 1975; Potter, 1966).

Method

Subjects

The study involved 128 subjects: 96 children from private schools (32 each from kindergarten, third and sixth grade) and 32

college students from introductory psychology courses. The children's mean ages were 5-9, 8-11, and 12-0 for kindergarten, third, and sixth grades, respectively. Each subject was tested individually at his or her own school.

Design

The design was a 4 x 2 x 2 complete factorial. Grade level (kindergarten, third, sixth, or college) was a between-groups factor; two organizational factors, Structural Integration (integrated or unintegrated) and Thematic Content (coherent or anomalous), were varied within-subjects.

Stimuli

Thematic Content was varied by manipulating the probability that a set of pictured components would occur together in a real-world scene. Each scene contained four items, three of the four items in each scene were context items. A fourth item in each scene was a critical, probe item that determined whether the scene was thematically coherent or anomalous. For example, in Figure 1(a) the context items

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Insert Figure 1 about here

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are the sofa, chair, and footstool; the probe is either the T.V. or playground swing. Scenes containing the T.V. probe are coherent; scenes containing the swing probe are anomalous. In Figure 1(b) the probe roles are reversed; the swing is a coherent probe while the T.V. is an anomalous probe among the context items, sandbox, see-saw and

scooter.

Only the single probe item (e.g., T.V. or swing) served as a target on the yes/no recognition test. In order to diminish possible probe selection artifacts and to permit a recognition test of targets against semantically related distractors, an additional anomalous and coherent probe item was produced for each scene. For example, equal numbers of subjects viewed a stereo or slide probe among the context items in Figure 1. If the target was a T.V., the distractor was a stereo; if the target was a swing the distractor was a slide. The related probes served alternately as either targets or distractors for equal numbers of subjects.

Sturctural integration was varied by presenting the scene components arranged either naturalistically (integrated) or horizontally (unintegrated). Probes were assigned equally to one of four positions across the center of the slide. In unintegrated scenes, the context items occupied the remaining three horizontal positions; in integrated scenes, the context items were placed in an arbitrary naturalistic arrangement around the probe. Probes for integrated (two top pictures in Figure 1(a) and 1(b) and unintegrated (two bottom pictures in Figure 1(a) and 1(b) versions of a scene occupied the same position.

Across subjects and within grades, scene components represented each organizational condition equally often. Each subject saw only one scene corresponding to a particular set of probes. Four instances of each organizational treatment condition were dis-

tributed randomly in a 16-item acquisition list with the restriction that not more than two slides representing the same condition occur in succession.

Two recognition test lists each contained 32 items: The 16 probes from the acquisition scenes mixed with their respective semantically related distractors (e.g., T.V./stereo or swing/slide). Test items were presented individually with the same order restriction as imposed in constructing acquisition lists.

In pilot studies it was established that children as young as four years of age could identify the individual items contained in the scenes. In addition, it was determined from college students' ratings that the scenes could be discriminated along both organizational dimensions.

Materials and Apparatus

Black and white line drawings were photographed and presented as 35mm negative slides. The slides were rear projected on a Polacoat Lenscreen with a Kodak (model 750H) carousel projector. The timing mechanism of the projector regulated slide presentation duration at 4 sec, with an interstimulus interval of approximately .75 sec.

Procedure

During acquisition, subjects viewed 16 slides. Task instructions directed subjects to look at each slide carefully, because later they would be shown some of the pictures again to see if they remembered them. A one-item slide was shown to familiarize the subject with the nature of presentation, then the acquisition list was shown.

Following acquisition, the experimenter changed slide trays and gave the recognition test instructions. Subjects were told to respond "yes" if an item had appeared as part of an earlier slide and "no" if the item had not appeared previously. The experimenter quizzed the subject and rephrased the instructions if necessary to ensure the task was understood. Test items were then presented individually, remaining in view until the subject responded and the experimenter had recorded the response.

Results

Separate 4 (Grade) x 2 (Structural Integration) x 2 (Thematic Content) mixed analyses of variance were computed for proportions of false alarms, hits, and correct responses. Analysis of *d'* was also done using Elliott's (1964) tables to calculate *d'* values. Differential response biases evident in the data made this analysis necessary in order to clarify interpretation of effects obtained with the other measures that do not take response bias into account. The results of the different analyses of variance will be presented together because they provided converging evidence of the same basic findings. Measures of response biases will then be presented.

Main effects of grade were obtained in all analyses. The respective *F*'s(3, 124), *p* .01 associated with each dependent measure were 4.46 for false alarms, 17.85 for hits, 9.59 for proportion correct, and 7.76 for *d'*. Group means for *d'* were 1.71, 1.81, 1.99, and 2.57 for kindergarten, third and sixth grade, and college, respectively.

Insert Figure 2 about here

Figure 2 illustrates the relationship between Grade and the remaining dependent measures. For hits, proportion correct, and d', multiple comparisons (Tukey b) indicated that college students performed significantly ($p < .05$) better than all children's groups; in addition, third and sixth graders had higher hit and false alarm rates than kindergarteners. No other comparisons were significantly different.

Main effects of thematic content were obtained for false alarms, proportion correct, and d'. As Table 1 shows, performance was

Insert Table 1 about here

better for anomalous than coherent scene information, across all age groups tested.

The proportion of total responses that were "yes" responses (P("o")) provides an estimate of a subject's response bias (Creelman & Donaldson, 1968). These proportions increased with developmental level; inspection of Table 2 shows that kindergarteners made the fewest "yes" responses, clearly indicating a more conservative response bias than than the older children and adults. By analyzing d', memory strength was assessed independently of a subject's response bias. The results

Insert Table 2 about here

of the d' analysis was consistent with the findings from analyses done on the other dependent measures and indicated that response bias apparently did not interact with any of the organizational treatments. Further, regardless of a subject's bias to respond "yes", both the proportion of "old" responses made to old items (P(o/"o")) and the proportion of "old" responses made to the different treatment conditions (P(t/"o")) remained constant across the age groups studied, as shown in Table 2.

Discussion

The present study was designed to investigate developmental differences in recognition memory for information in complex pictures varying in content and structure. The results indicate: Clear effects of thematic content on retention of information in complex pictures, age-related changes in recognition response patterns, and an overall improvement in recognition accuracy between sixth grade and college. Perhaps the most interesting finding is the developmental stability of the organizational treatment effects in light of clear developmental shifts in response criteria. Discussion will focus first on the effects of scene organization on memory, followed by consideration of the age-related increments in recognition accuracy and changes in response trends.

Three sources of data, proportions correct, d', and false alarm measures, provide converging evidence supporting the notions of Loftus and Bell (1975) and Biederman et al. (1974) regarding facilitated encoding and recognition of informative scene components as opposed to those adding only to the general meaning of a scene. Low probability, anomalous items were more accurately recognized and less often sources of distractor confusion than items commonly occurring together. This may be taken as an indication that anomalous probes were encoded and remembered separately, while probes from thematically well-organized scenes were encoded and remembered in terms of the general meaning of the scene. Further, the effect of distractor confusion remained constant across developmental levels despite different levels of false positive responding. It appears that thematic encoding can be used to represent integrated and unintegrated multicomponent pictures at a very young age (cf. Denney, 1974).

Unlike the Mandler and Stein (1974) findings the youngest children in the present study did not process structurally integrated and unintegrated scene differently. This finding is consistent with adult performance (Mandler & Johnson, 1976; Mandler & Parker, 1976) and extends the hypothesis that scene structure has little influence on recognition of item or inventory information down the developmental scale. Further, the discrepancy between the present results and those of Mandler and Stein are probably attributable to differences in task demands and stimulus characteristics of the studies. The task used by Mandler and Stein (1974) required recognition of composite scenes

following a small transformation of one component while the present study required recognition of single components. Further, Mandler and Stein's organization effect derived mainly from performance on size and rearrangement transformations that one would expect to be more readily detected in structurally organized rather than unorganized scenes.

More generally, the results of the present study provide information regarding developmental aspects of recognition memory itself. Data indicating that children's recognition for pictures is extremely good (e.g., Brown & Campione, 1972; Brown & Scott, 1971; Corsini, Jacobus & Leonard, 1969) and difficulty in detecting developmental improvements in recognition memory (e.g., Nelson, 1971) led theorists to hypothesize that recognition memory was a relatively simple automatic process (Kintsch, 1970) insensitive to developmental changes (Brown, 1973). However, recent empirical and theoretical considerations have led to a reinterpretation of the developmental aspects of the recognition memory paradigm.

The observed improvement in recognition accuracy between sixth grade and college in this study concurs with other recent reports of age-related increments in picture recognition memory (e.g., Fleming & Sheikhian, 1972; Hoffman & Dick, 1976; Mandler & Stein, 1974). Hoffman and Dick (1976) suggest that younger subjects are less effective than older in extracting and organizing pictured information during storage and retrieval, and that performance differentials reflect a processing deficiency rather a capacity limitation. The present data

support this contention, especially considering that the relatively small number of pictures presented to the subject is unlikely to have exceeded the child's capacity (cf. Brown & Scott, 1971).

The data also provide empirical support of a restatement of Brown's theoretical position. Brown (1975) proposes that developmental differences in memory performance will be observed to the extent that tasks (a) tax the strategic repertoire of an individual and/or (b) involve reliance on semantic rather than episodic memory systems (Tulving, 1972). Brown also maintains that it may be difficult to determine whether the source of memory improvement is due to "effects of deliberate [strategic] intervention [or] from effects due to general cognitive maturation" (p. 144). It seem probable that the present task of recognizing components rather than composites of complex pictures may have required different types of retrieval activities than are usually used in recognition tasks (Kintsch, 1970) and that may be beyond the strategic repertoire of children (Flavell, 1970; Hagen et al., 1975). The thematic content effect suggests that subjects of all ages encoded scenes as units or wholistically, rather than as a series of discrete elements. Therefore it seem likely that during recognition of single components, subjects had to actively seek out the composite corresponding to the probe to determine whether an item had been presented or not. It is quite possible that such a strategy would be used more efficiently by older than younger subjects, thus favoring performance of the cognitively more mature individual.

In addition to the developmental improvements in recognition

accuracy, the patterns of "yes" responses indicate another age-related performance difference. Two patterns should be noted: a) Between kindergarten and third grade children became much less conservative in responding, and b) the probability that an item was "old" given a "yes" response remained high (.8) and fairly constant across the kindergarten through college period.

A similar conservative bias of kindergarteners relative to third graders has been reported by Berch and Evans (1973) and by Brown and Campione (1972) among preschool children, although Perlmutter and Myers (1974; 1975; 1976) have consistently reported no significant differences in response criteria for two- to four-year-olds. Direct comparison of these findings is difficult due to variation in task demands, procedures, and age groups. However, differences in task difficulty may best account for the discrepancies (Goldstein & Chance, 1974). The present task, as well as the continuous recognition of numbers (Berch & Evans) or of similar vs. identical pictures (Brown & Campione), appears more difficult than Perlmutter and Myers' yes/no recognition of unrelated objects, pictures, or words. As task difficulty increases, subjects appear to adopt more conservative response criteria. Further, regardless of differences in task difficulty, these studies are consistent in demonstrating at least a trend in the direction of increasingly conservative responding with deceasing chronological age. The magnitude of this trend seems to be related to task difficulty.

Finally, the probability that an item was "old" given that an

individual made a "yes" response remained quite high and consistent across differences in response bias or memory accuracy associated with developmental level. As Brown and Campione (1972) suggest, it appears that if kindergarteners are sure that an item is "old" they respond "yes"; if they are unsure, they respond "no". Young children may be less confident and hence give more "no" responses than older children, but the accuracy of "yes" responses given to "old" items is comparable across age groups. Perhaps this reflects equivalent metamemorial expertise in judging, according to a selected criteria, when "yes" responses are appropriate.

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Footnote

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TABLE 1

Means for Main Effects of Thematic Content

Dependent Measure	Thematic Content		
	Coherent	Anomalous	$F(1, 124)$
False Alarms	.21	.13	19.99***
Proportion Correct	.73	.76	5.26*
d'	1.86	2.18	7.23**

*p .05
**p .01
***p .001

TABLE 2

Summary of "yes" Responding across Organizational Treatments

	Grade Level			
	Kindergarten	Third	Sixth	College
P("o")[a]	.300	.421	.442	.485
P(o/"o")[a]	.828	.784	.786	.828
P(t/"o")[a]	.246	.247	.247	.249

[a] See text for explanation.

Figure Captions

Figure 1. Examples of the four organizational treatment conditions for one scene pair. In 1(a) the television is a coherent probe (target) and the swing an anomalous probe (target); in 1(b) the roles of the probes (targets) are reversed. The respective distractors would be a stereo for scenes with a television and a slide for scenes with a swing.

Figure 2. Mean proportions for each grade collapsed across the organizational conditions, for three dependent measures.

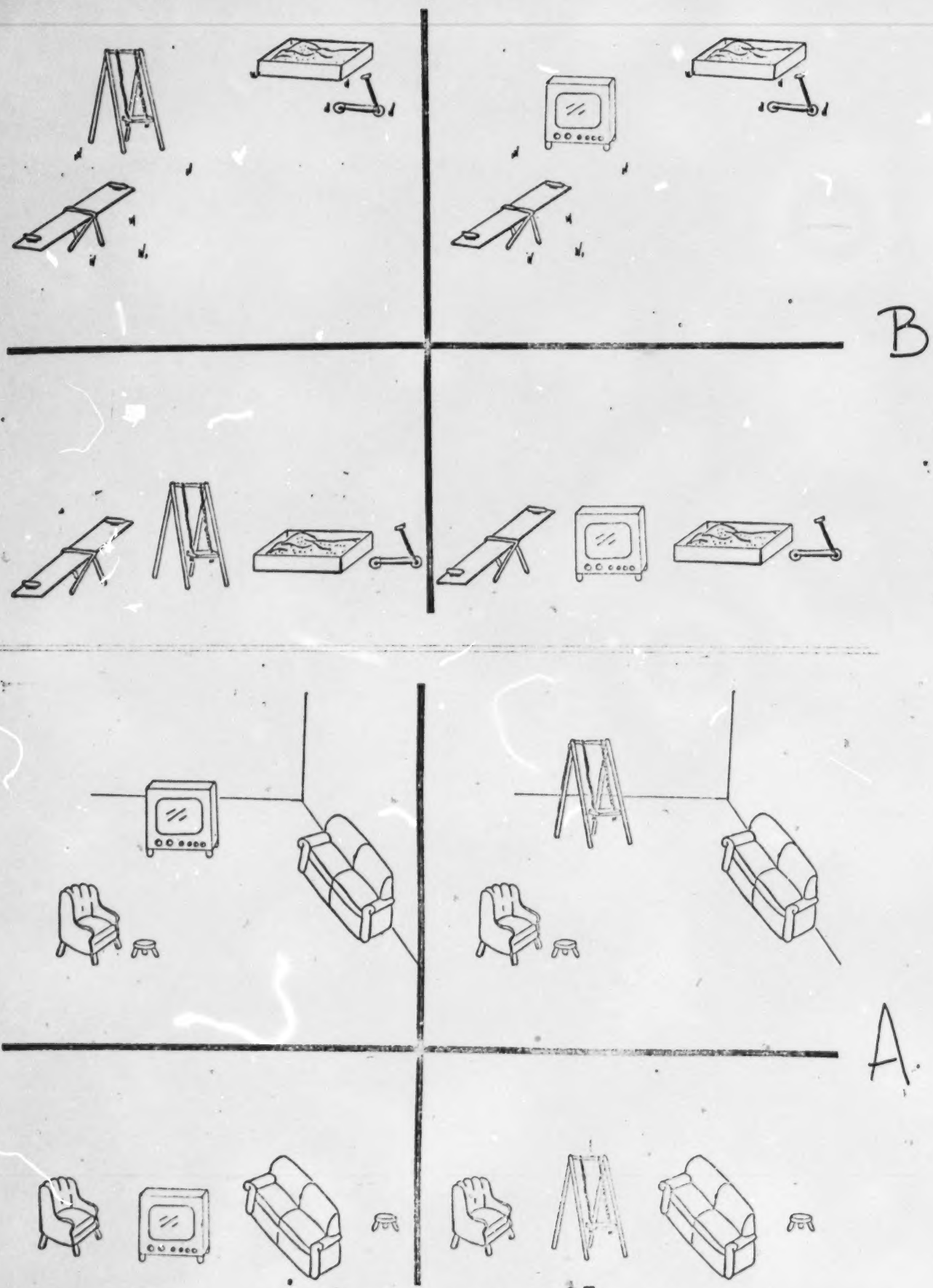
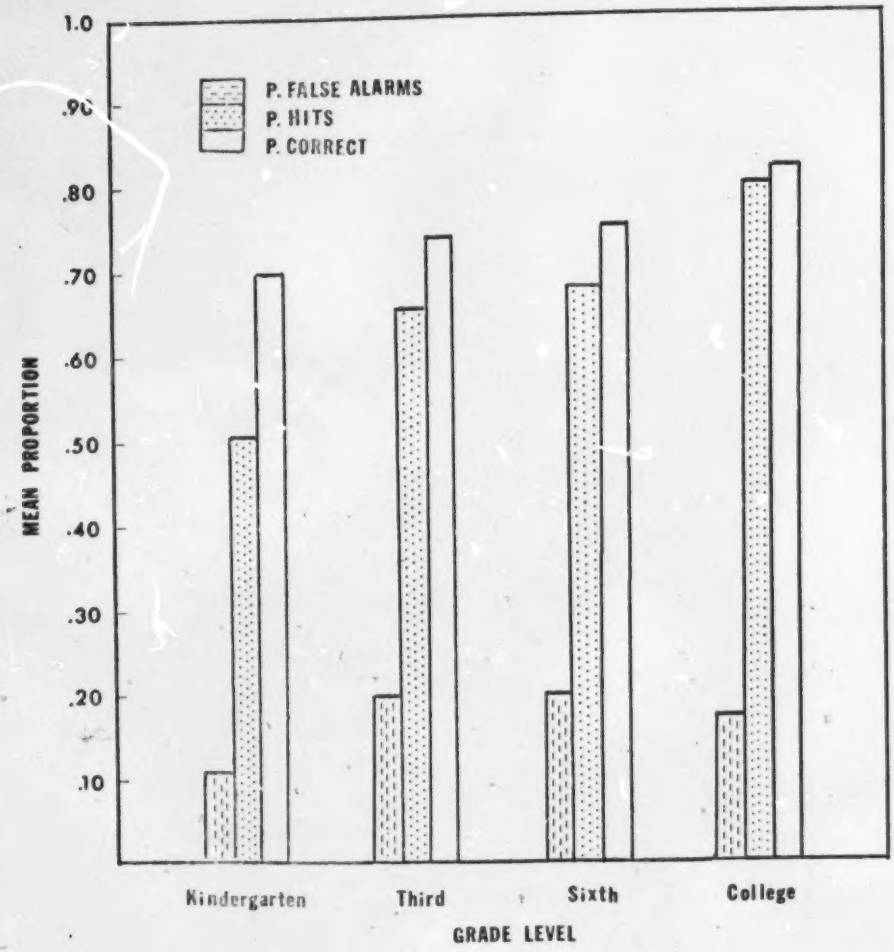


FIGURE 1


1.0
.90
.80
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.20
.10
MEAN PROPORTION
P. FALSE ALARMS
P. HITS
P. CORRECT
Kindergarten
Third
Sixth
College
GRADE LEVEL

Fig. 2